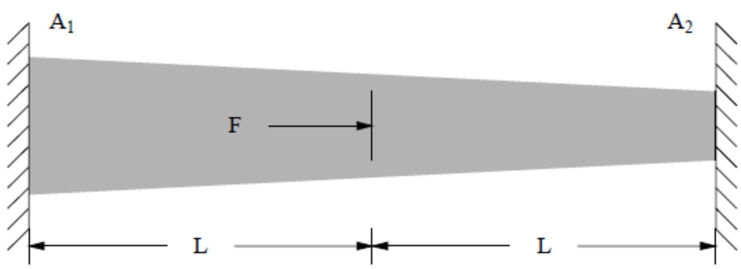
Finite Element Course

Assignment 4

Problem 1

Consider solution of a tapered axially loaded bar shown in the Figure. Divide the bar into two finite elements and determine the axial force distribution in the bar. Plot this force distribution. Compute the support reactions from the force distribution and see whether the overall equilibrium is satisfied. Comment on the quality of the finite element solution. Use the following numerical data.

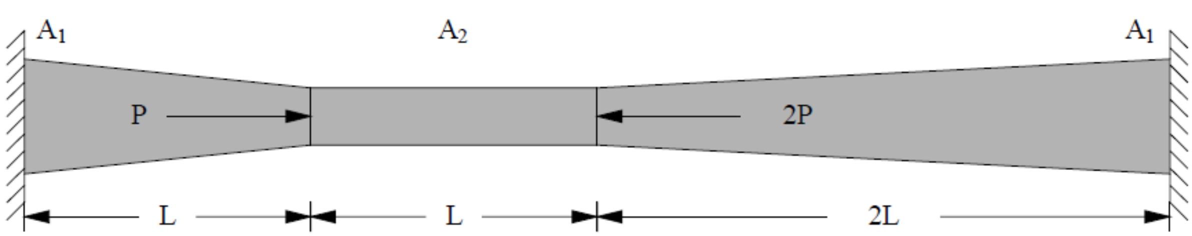
$E = 70$ GPa; $F = 20$kN; $L = 300$mm; $A_1 = 2400\text{mm}^2$; $A_2 = 600\text{mm}^2$



Problem 2

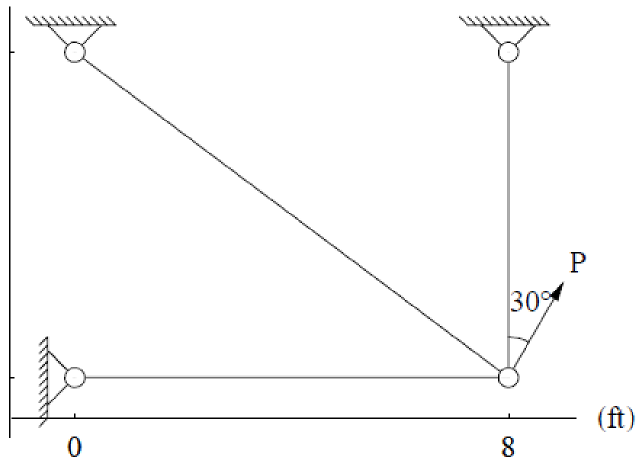
Consider solution of the axially loaded bar shown in the Figure. The two end segments have linearly varying areas of cross-section and the middle segment is of uniform cross-section. Divide the bar into four equal length finite elements and determine the axial stress and force distribution in the bar. Compute the support reactions from the axial forces and check to see if the overall equilibrium is satisfied. Plot the stress distribution and comment on the accuracy of the finite element solution. Use the following numerical data.

$E = 70$ GPa; $P = 20$ kN; $L = 300$ mm; $A_1 = 2400\ \text{mm}^2$; $A_2 = 600\ \text{mm}^2$



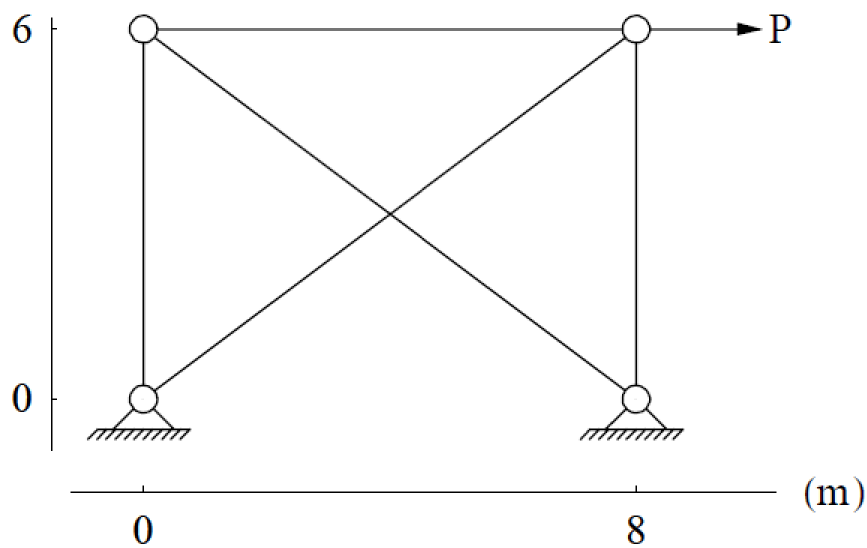
Problem 3

Determine joint displacements and axial forces in the truss shown in Figure. All members have the same cross-sectional area and are of the same material, $A = 2 \text{ in}^2$ and $E = 30 \times 10^6 \text{ lb/in}^2$. The load $P = 30{,}000$ lb. The dimensions in ft are shown in the figure.



Problem 4

Determine joint displacements and axial forces in the truss shown in Figure. Note the diagonals are not connected to each other at their crossing. The cross-sectional area of vertical and horizontal members is
$30 \times 10^{-4} \text{ m}^2$ and that for the diagonals is $10 \times 10^{-4} \text{ m}^2$. All members are made of steel with $E = 210$ GPa. The load $P = 20$ kN. The dimensions in meters are shown in the figure.

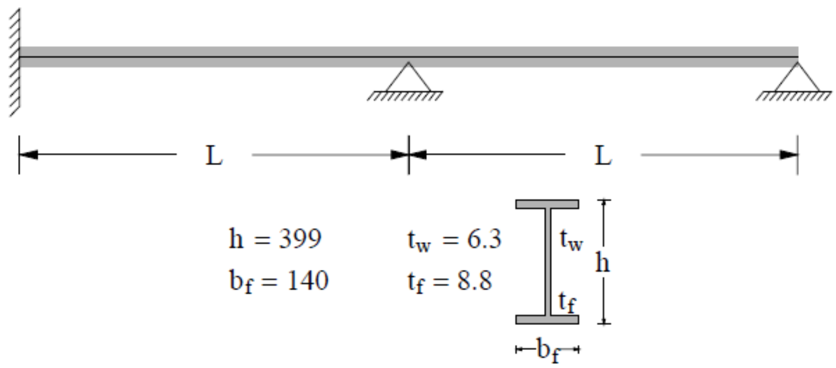


Problem 5

Immediately after construction the right support of the beam shown in the Figure 4.64 undergoes a settlement equal to D. Find resulting displacement, shear force and bending moments. Compute shear and bending stresses at the middle support in the beam. Use the following numerical data.

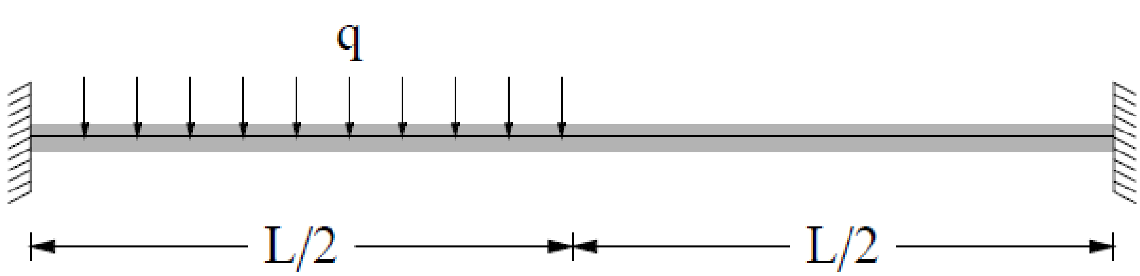
L = 8 m ; E = 200 GPa ; Δ = 10 mm

Beam cross-section: Standard I-shape with I = 125.3 x 10^{-6} m^4 and dimensions (in mm) as shown in the figure.



Problem 6

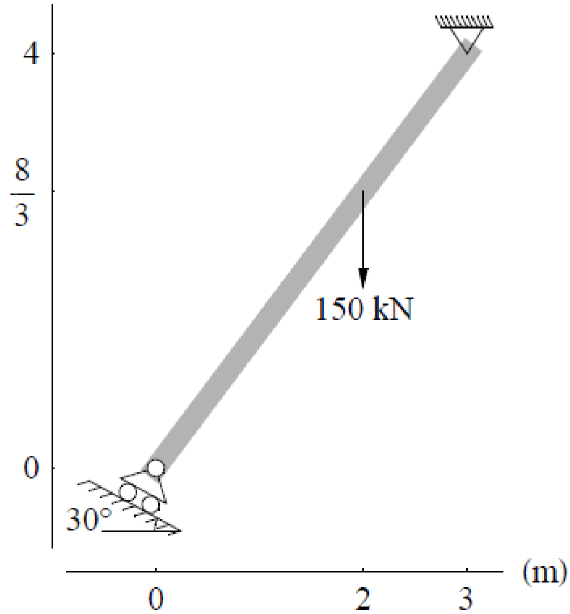
Left half of a beam is subjected to a uniformly distributed load q = 1 lb/in as shown in the figure. The beam has a rectangular cross-section with width =12 in and height = 1 in. The length of the beam is L = 200 in and its modulus of elasticity is E = 10^7 lb/in^2.



Create the simplest possible finite element model for this beam. Using this model determine the bending and shear stresses in the beam at L/4 from the left end.

Problem 7

A 300 mm wide and 100 mm thick bar is supported and loaded as shown in the Figure. Determine displacement, shear force and bending moments. E = 10 GPa.



Problem 8

Determine displacements, bending moments, and shear forces in the plane frame shown in Figure. Draw free body diagrams for each element clearly showing all element end forces and moments. Assume q = 10 kN/m, L=2 m, E = 210 GPa, A = 4 x10^{-2} m^2, I = 4 x10^{-4} m^4. Take advantage of symmetry.